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Inventor: Kenichi Yoneyama
Kyocera K.K., Universal Research Center, 1-4 Yamashita-cho, Kokubu-shi, Kagoshima, Japan
Inventor: Masashi Kato
Kyocera K.K., Universal Research Center, 1-4 Yamashita-cho, Kokubu-shi, Kagoshima, Japan
Inventor: Kiyoharu Sakasegawa
Kyocera K.K., Universal Research Center, 1-4 Yamashita-cho, Kokubu-shi, Kagoshima, Japan
Applicant: Kyocera K.K.
6 Takeda Tobadencho, Fushimi-ku, Kyoto, Japan

DETAILED REPORT

(Name of the invention)
cell walls for plasma display panel and manufacturing method of the same

Outline
(Object)

This invention offers cell walls for a plasma display panel and manufacturing method of the same which reduces defects in the shape of cell walls which form the electric discharge display cell of the PDP. The base of the cell wall which is attached to the back plate is a curved surface which has a uniform radius of curvature. The thickness of the luminous layer on the bottom of the electric discharge display cell is uniform and has no cracks. These cell walls for the PDP form electric discharge display cells which are highly detailed and accurate. These cell walls for the PDP can easily be used for a big screen. The manufacturing method in this invention can be used to produce these cells inexpensively and effectively.

(Construction)

A layer of material for forming cell wall is coated on the back plate and then molded to form the cell walls. These molded cell walls are treated with a release process with the back board. After sintering, they are united and cell walls for a plasma display panel where the shape of the base of the cell walls is a curved surface which has a radius of curvature in the range of 10 to 100 μm is acquired.

Sphere of patent request

(claim 1)

Claim 1 is regarding cell walls for plasma display panel where the shape of the base of the cell walls attached to the back plate is a curved surface which has radius of curvature in the range of 10 to 100 μm. In this plasma display panel, multiple electric discharge display cells are constructed from an insulating substrate, a back plate and front plate, and cell walls which separate the space between the insulating substrates. Multiple electrode groups are set up inside the electric discharge display cell. At the same time, an electric discharge gas contained by an air tight seal. Voltage is selectively applied between the electrodes, and a plasma is produced. A luminous plasma is formed inside the electric discharge display cell, and it is used as the light-emitting element of a display screen device.

(claim 2)

Claim 2 is regarding a manufacturing method for cell walls for a plasma display panel which has the following characteristics. First, material for forming the cell walls is coated on a back plate. Next, this coated layer is molded into cell walls. These molded cell walls are treated with a release process with back board. After sintering, they are united to form cell

walls for a plasma display panel with curved bases which have a radius of curvature in the range of 10 to 100 μm.

(claim 3)

Claim 3 is regarding a manufacturing method for cell walls for a plasma display panel which has the following characteristics. After the cell walls are molded by a plasticizing transformation and pressing the mold for cell wall onto the plastic material, the molded cell walls are tightly bonded by pressing a back plate on the molded cell walls. After releasing them, they are sintered and bonded to the back plate. Cell walls for a plasma display panel where the wall base has a curved surface with a radius of curvature in the range of 10 to 100 μm are acquired.

(claim 4)

Claim 4 is regarding the manufacturing method for cell walls for a plasma display panel in claim 2 or 3 which has the following characteristics. The cell walls are formed by pressing a series of rollers into the cell wall material.

Detailed explanation of the invention

[0001]
(Field of industrial use)

This invention is concerning cell walls for a PDP which are used as the electric discharge display cells of a plasma display panel (a PDP in the following) that is used for a thin, light weight color display screen. This invention be used to make a big, inexpensive screen with high accuracy. This invention also includes a manufacturing method for the same.

[0002]
(Prior art)

CRT's have formerly been used as display screens. However, CRT's are big and heavy and high voltage is necessary. Recently, with the growing popularity of multi media, flat screen display devices such as light emitting diodes (LED) or liquid crystal display elements (LCD) have been developed. Their range of applications has been enlarged.

[0003] Among these, PDP's have been gaining attention as color display devices for big screens. Plasma illumination has high quality, light weight, is thin, and is not particular about its location.

[0004] A PDP is constructed as follows: groups of opposing electrodes are set up in tiny electric discharge display cells between two flat insulating substrates. Cell walls separate these calls. A gas such as a rare gas is sealed in the se cells by an airtight seal. Voltage is selectively applied to the opposing electrodes, and plasma is produced by an electric discharge. Next, a body inside the electric discharge display cell is illuminated by the plasma, and it is used as a light-emitting element of a display screen.

[0005] The following general manufacturing methods for cell walls which constitute the electric discharge display cells of the PDP are well known. In these methods, printing and drying of a paste composition for molding cell walls is repeated on the back plate in the desired pattern by screen printing. The cell wall is formed by forming layers up to the desired height.

[0006] However, in this method the film thickness which can be formed in one printing is approximately 10 μm, so it is necessary to build up the cell walls by repeating printing and drying because the cell walls of an electric discharge display cell require a height of approximately 100 to 200 μm.

[0007] Not only are there too many process steps, but excess material piles up in the bottom of the cells.. In addition, the base of the cell wall which is bonded to the back plate is distorted due to the mesh of the printing plate making. The cell walls are deformed by positioning between repeated printings. In addition to stretch during printing plate making, these factors make it difficult to acquire good dimensional accuracy. This makes a lower limit on the pitch of the cells which can be formed. As a result, it is impossible to satisfy demands of high accuracy. Also, since it is necessary to print with accuracy at every lamination, you can't stop in the middle.

[0008] Therefore, the following methods have been suggested to solve these problems. (Japan patent No. H 8-115669) First, cell wall materials are formed in layers on a back plate to the

necessary thickness. Next, unnecessary parts are polished and removed by sandblasting using a mask, and cell walls in the desired shape are formed.

[0009]
(Problems that this invention tries to solve)

With this sandblasting method, it is possible to form cell walls with the desired standing sectional shape. The base of the cell wall will not be distorted and the bottom part will not be enlarged as in the screen printing lamination method. However, in this processing method, it is necessary to polish and remove a lot of cell wall material other than the part which forms the walls. This makes the cost high.

[0010] In addition, when long, thin and extremely narrow cell walls are molded in order to form electric discharge display cells with even higher accuracy, the high cell walls are weak in the direction perpendicular to the cell walls. Cracks are produced when the cell walls are formed, or during sintering. The cell walls can also be damaged during subsequent handling.

[0011] When the cell walls have a standing sectional shape after sintering as shown in figure 4, the corner 17 formed between the back plate 15 and base of the cell walls 16 is irregularly rounded. When the luminous layer 19 is formed in the bottom of the electric discharge display cell 18, there have been problems completely filling the cell, controlling the thickness of the luminous layer, or cracking 20 during sintering. Also, light-emitting efficiency is reduced and luminosity is uneven.

[0012]
(Object of this invention)

This invention was made in order to solve the above problems. Its object is to offer cell walls for a plasma display panel and a manufacturing method for the same. This reduces defects such as voids in the cell walls which constitute the electric discharge display cells of a PDP, and it improves productivity. The cross section of the base of the cell wall is highly accurate. The cells can have a fine pitch when attached to the back plate. The walls join the base plate in a curved surface with a uniform radius of curvature. The luminous layer formed on the bottom of the electric discharge display cells is uniform and crack free. These cell walls for PDP make highly accurate, detailed electric discharge display cells. These cell walls for PDP can easily be used for a big screen such as 30 inches or more. The manufacturing method in this invention can be used to produce these cell walls inexpensively and effectively.

[0013]
(Steps for solution)

The inventors of this invention made through research on this subject with the following results. The cell walls which form the electric discharge display cells are formed by plastic deformation of the wall material. The cross section is a curved surface with a fixed radius of curvature at the base. Because of this, it is possible to prevent defects such as missing parts during handling or cracking of the cell walls. At the same time, it is possible to form a luminous layer with uniform thickness without defects such as cracks in bottom of electric discharge display cell. High accuracy and high detail can be realized.

[0014] The cell walls in this invention have the following characteristics. The sectional shape of the base of the cell walls makes a curved surface which has a radius of curvature in the range of 10 to 100 μm where it joins the back plate. This shape is formed by plastic deformation of the cell wall material.

[0015] The manufacturing method for cell walls for PDP in this invention has the following characteristic. First, a predetermined thickness of cell wall material is applied in a layer on a back plate. Next, this coated layer plastically deformed into the cell wall shape. The back plate where the cell walls molding has been bonded are debindered and sintered. Cell walls for a plasma display panel where the sectional shape of the wall base where it is attached to the back plate has a curved surface with a radius of curvature in the range of 10 to 100 μm, are acquired.

[0016] In addition, there is another manufacturing method for cell walls for PDP which has the following characteristics. After the cell walls are formed by plastic deformation by directly pressing the wall mold onto the wall material, the molding is tightly bonded to the back plate by pressure. After de-bindering, it is sintered attached to the back plate. Cell walls for a plasma display panel where the base of the cell walls makes a curved surface with a radius of curvature in the range of 10 to 100 μm are acquired.

[0017] Te following method is best for forming cell walls by plastic deformation of the wall material. Multiple groove in the shape of the cell walls are formed. The cell walls are formed by pressing and rotating a roll-shaped mold which has projections in the desired circular shape with a predetermined curvature.

[0018]

(Function)

In the cell walls for PDP and manufacturing method in this invention, the wall section at the base where the wall attaches to the back plate has a radius of curvature in a fixed range. In the manufacturing method, a layer of wall material formed on a back plate is plastically deformed to form the cell walls. After this cell wall molding is de-bindered, it is sintered, and attached to the back plate. Therefore, the wall base will be a curved surface with a uniform radius of curvature. It is also possible to reduce stress concentration at the cell wall base. At the same time, it is possible to increase the sectional area of the cell walls compared to cell walls which consist of only long thin sectional shapes. It is possible to improve the strength of the cell walls in the direction perpendicular to the length.. The manufacturing process is improved by reducing defects such as deformation or voids in the cell walls. The base of the cell walls will have a uniform curved surface and they can be easily reproduced by a simple process. It is also possible to make a uniform layer of luminous material. Overall, reduce manufacturing costs can be greatly reduced.

[0019]

(State of practice of this invention)

In the following, cell walls for PDP of this invention and the manufacturing method are going to be explained in detail based on figures.

[0020] Figure 1 shows one example of practice of a PDP which uses the cell walls in this invention. Figure 2 is a section of the main part of the cell walls for PDP in this invention.

[0021] In figure 1 and figure 2, 1 is the cell walls for PDP used in the PDP 9 that consists of an insulating substrate 4 used to make a back plate 2 and a front plate 3, and electric discharge cell 5 which has multiple electrodes 6, 7 and luminous material 8.

[0022] In the cell wall 1 for PDP, the cell wall section at the base 10 where they attach to the back plate 2 has a uniform curved surface 11 within a fixed range curvature.

[0023] In this invention, the radius of concerning of the curved surface 11 made by the base part 10 of the cell walls attached to the back plate 2 must be greater than 10 μm and less than 100 μm. When even one part of the curved surface 11 is less than 10 μm looking from the center direction of the electric discharge display cell 5, the effect of this invention which reduces deformation or missing parts is reduced. On the other hand, if it exceeds 100 μm, although cell wall durability is improved, the luminous area is reduced luminosity is decreased.

[0024] As long as the radius of the curved surface 11 made by the cell wall base 10, regardless of size electric discharge display cell 5, is in the range of 10 to 100 μm, it can have a fixed radius of curvature, it can be an oval where the radius of curvature is continually changing, or other curved surface with various shapes. Among these, for ease of manufacturing the mold, 15 to 70 μm is the best.

[0025] Next, the manufacturing method for cell walls for PDP in this invention is going to be explained. In the example shown in figure 3, a layer 12 of cell wall material is formed on a back plate 2 and plastically deformed to form cell walls 1 for PDP. The cell wall section will be a curved surface 11 with a fixed radius of curvature.

[0026] The following method is especially efficient, and it makes mass-production with high accuracy possible. First, a roll-shaped mold 14 with multiple grooves 13 equivalent to the shape of the cell walls and having the desired radius of curvature for the wall base is pressed onto a layer 12 of cell wall material while rotating in the direction of the arrow. Next, the shape of the cell walls is transcribed by plastic deformation of the coated layer 12. A cell wall molding which has a curved surface 11 at the wall base attached to a back plate 2 is acquired.

[0027] The plastic deformation process for the layer of cell wall material is not specifically limited. For instance, in addition to forming the cell wall molding by pressing various kinds of flat or roll shaped molds corresponding to the sectional shape of cell walls into the layer on the back plate, it is possible to press the mold for cell walls above onto the cell wall material without a backing plate. In another method, it is possible after pressing the mold into the cell wall material or pressing the cell wall material onto the mold to transcribe the back plate and press the cell wall material onto it.

[0028] As long as the cell wall material becomes hard after sintering and is airtight, any material can be used. For instance, it is possible to use a mixture of low-melting point glass powder and ceramic oxide powder as inorganic components. A mixture of inorganic components and organic substances such as binders, solvents, or various kinds of additives can be used depending on the requirements of the molding method.

[0029] Organic binders which are suitable materials for molding cell walls include, for example, acryl or butyral based thermo plastic binders or reaction curing resins such as UV curing, light-curing, or thermal curing resin.

[0030] The method for plastic deformation of the coated layer of cell wall material above which is formed on back board can include, other than adding organic substance which can be

deformed plastically beforehand, it is possible to form the coated layer on the back plate first and then dry or gel the material in order to add plastic deformation.
[0031] In addition, the walls of the mold could be metal, resin, or rubber. These molds could be flat or a column shape with the cell wall pattern formed on its surface.
[0032] The insulating substrate which is used for the back plate and front plate of this invention can be a transparent substrate such as soda lime glass, low-soda glass, lead alkali silicon glass, or borosilicate glass. A soda glass with a high warp point is especially suitable.
[0033] Next, the electrode is formed using a conductive metal such as Ag, Ni, Al or their alloys. An electrically conductive paste made by mixing a small amount of glass with these metals or alloy can also be used. The front plate which is an insulating substrate on the display face side has transparent electrodes made vapor-deposited indium oxide or tin oxide.
[0034] The gas can have Xe or He-Xe, Ne-Xe as the main component. It is possible to form an electric discharge display cell where the gas pressure in the sealed cell is 10 to 600 Torr.

[0035]
(Examples of practice)

In the following, the cell walls for PDP in this invention and the manufacturing method are evaluated as explained below.
[0036]
(Example of practice 1)

First, a back plate which consisted of 2 mm thick soda lime glass 30 inches square was coated with an Ag based electrode paste by a thick film printing method to form 50 μm wide stripe electrodes with 220 μm pitch over the whole surface. After sintering, an electrode plate was manufactured.
[0037] Meanwhile, a flat metal cell wall mold was prepared. The wall section at the base was a curved surface with approximately 9 μm radius of curvature as seen from the center of the electric discharge display cell. Multiple grooves in the shape of the cell walls 40 μm wide, 200 μm high, and 220 μm pitch were formed on the mold.
[0038] Next, cell wall material which consisted of low-melting point glass powder, butyral resin, solvent, and a dispersing agent was applied uniformly on the electrode plate above using a roll coater. Then the flat metal cell wall mold above was pressed onto the coated layer to plastically deform it to form the cell walls in the desired shape. Next, the cell walls molding was released from the mold, and a cell wall molding was formed on the back plate.
[0039] After that, the assembly of back plate and cell wall molding was kept at a predetermined temperature and de-bindered. The sintering atmosphere was changed appropriately depending on the materials used. After sintering for 10 minutes at 550 to 580 C, cell walls for PDP attached to a back plate were manufactured.
[0040] When the shape of the cell wall base for PDP acquired above was observed by scanning electron microscope (SEM), it showed a uniform curved surface with approximately 10 μm radius of curvature.
[0041] The back plate with electrodes attached to the cell walls (before sintering) was passed through a line air shower at 1.0 air pressure and 10 cm height from back board with the cell walls facing up. After that, damage was assessed at 5 places – in the center and at the four

corners. The numbers of voids deformed cells per unit area (cm2) was counted, and the strength of the cell walls was evaluated.

[0042] The cell walls for PDP were evaluated after sintering by passing them under one line air shower at 5.0 pressure, and the strength of the cell walls was evaluated as was done before sintering.

[0043] A glass layer 200 μm thick was formed on a back plate using glass paste. After it was dried, a striped mask which had been set to the width of cell walls (approximately 40 μm) was used to form cell walls. These cell walls were sand blasted using glass beads at a pressure of approximately 1.5 to 3.0 kgf/cm2. This was used as an example of comparison.

[0044] The cell wall section at the base was straight and the cell walls were almost perpendicular to the back plate.

[0045] In the example of comparison, it was found that the number of defects per unit area was 10 in the center of the back plate, 11 in the upper right corner, 12 in the lower right corner, 9 in the lower left corner, and 13 in the upper left corner. Therefore, the strength of the cell walls was thought to be low. Compared to this, the molded cell walls for PDP in this invention had only one defect in the center of the back plate, and there was no defects or voids in other areas. The strength of the cell walls was thought to be high.

[0046]

(example of practice 2)

Example of practice 2 was the same as example of practice 1, except that the cell wall material was applied by a roll coater and dried for 1 hour at 80 C.

[0047] When the sectional shape of the cell wall base acquired in this example of practice was measured as in example of practice 1, it had a uniform curved surface with approximately 13 μm radius of curvature.

[0048] In addition, as a result of the same evaluation as in example of practice 1, there was no deformation or voids anywhere in the raw molding or after sintering. The strength of the cell walls was thought to be extremely high.

[0049]

(example of practice 3)

Using the same cell wall material as in example of practice 1, a block of cell wall material was pressed onto the mold and plastically deformed to form a cell wall molding. Next, a back plate was pressed onto this cell wall molding, and they were bonded together. After de-bindering, it was sintered, and a cell walls for PDP molding attached to a back plate was manufactured.

[0050] Next, it was evaluated as in example of practice 1. A uniform curved surface with approximately 10 μm radius of curvature was acquired. The cell walls for PDP in this example had no damage such as deformation or voids either before or after sintering. This result confirmed that the strength of the cell walls was extremely high.

[0051]

(example of practice 4)

Instead the flat metal mold in example of practice 1, a roll-shaped metal mold with a radius of curvature of approximately 25 μm was used. This mold had multiple grooves equivalent to cell walls 35 μm wide, 200 μm high, and 150 μm pitch. This mold was used to transcribed a back plate with a layer of the same cell wall material as in example of practice 1. Next, the cell wall shape was formed by plastic deformation of the coating layer, and cell walls for PDP were manufactured as in example of practice 1.

[0052] When this example was evaluated as in example of practice 1, a uniform curved surface with approximately 30 μm radius of curvature was acquired. There was no damage such as deformation or voids either before or after sintering. The strength of the cell walls was extremely high.

[0053]

(example of practice 5)

Instead of the flat metal mold made for cell walls used in example of practice 1, a roll shaped metal mold with a radius of curvature of the base of the cell wall with approximately 50 μm radius of curvature was used. It had multiple grooves equivalent to the cell walls with 40 μm width, 220 μm height, and 220 μm pitch. Cell walls for PDP for evaluation were manufactured as in example of practice 2.

[0054] When these cell walls were evaluated as in example of practice 1, a uniform curved surface with approximately 55 μm radius of curvature was acquired. There was no damage such as deformation or voids either before or after sintering. The strength of the cell walls was extremely high.

[0055]

(example of practice 6)

Instead of the flat metal mold made for cell walls used in example of practice 1, a roll shaped metal mold with a radius of curvature of the base of the cell wall of approximately 95 μm radius of curvature was used. It had multiple grooves equivalent to cell walls with 40 μm width, 220 μm height, and 250 μm pitch. Cell walls for PDP for evaluation was manufactured as well as example of practice 2.

[0056] When these cell walls were evaluated as in example of practice 1, a uniform curved surface with approximately 100 μm radius of curvature was acquired. There was no damage such as deformation or voids either before or after sintering. The strength of the cell walls was extremely high.

[0057] It is noted that this invention is not limited specifically to the above examples of practice.

[0058]

(Effects of this invention)

By using the cell walls for PDP in this invention and the manufacturing method, it is possible to increase production of cell walls used for electric discharge display cells of a PDP. The strength of the cell walls in the perpendicular direction is high. Shape defects such as voids or deformed cell walls are reduced, the manufacturing process is improved, and productivity is

much improved. In addition, it is possible to form cell walls which have a uniform curved surface at the base.

[0059] Cell walls for PDP with the following features can be acquired. The sectional shape of the base of the cell wall is formed with high accuracy and fine pitch. They are attached to a back plate and the joint makes a curved surface with a uniform radius of curvature. The thickness of the luminous layer formed in the bottom of the electric discharge display cell is uniform and has no cracks. These cell walls for PDP make electric discharge display cells which are highly detailed and accurate. These cell walls for PDP can be easily used for big screens such as 30 inches or more. The manufacturing method in this invention can be used to produce these cell walls inexpensively and effectively.

[Simpler explanation of figures]

Figure 1: Cross section of one example of practice of a PDP which uses the cell walls for PDP in this invention.

Figure 2: Cross section of the main part for explaining the cell walls for PDP of this invention.

Figure 3: Cross section of a favorable example of practice of the manufacturing method for cell walls for PDP in this invention.

Figure 4: Cross section of the main part for explaining the cell walls for PDP in the former case.

[Explanation of symbols]

1: cell walls for PDP
2: back plate
3: front plate
4: insulating substrate
5: electric discharging cell
6, 7: electrode
8: luminous body
9: PDP
10: base of cell walls
11: curved surface
12: coated layer cell wall material
13: groove
14: roll-shaped mold